SECTION 15895
STAINLESS STEEL HIGH PRESSURE DUCTWORK AND ACCESSORIES (CERTIFIED MATERIALS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

A. This Section includes General requirements for the fabrication and installation of stainless steel piping (used as ductwork), having welded seams and joints for systems operating at velocities up to 5,000 fpm and 0- to minus -60 inches of water gage (WG) static pressure. These systems are as follows:
   1. Primary Confinement Exhaust (PCE) above grade.
   2. Hot Off-Gas (HOG) exhaust *above grade*.
   3. Hot Off-Gas (HOG) delay line *below grade* in engineered fill.
   4. Beam Dump Confinement Exhaust (BDCE).
   5. Back-Draft Damper (BDD, Safety Significant, as per ASME N509 Grade components).

B. For the PCE, HOG and BDCE exhaust systems the following components shall be included:
   1. Stainless Steel Exhaust piping
   2. Stainless Steel Exhaust transition ductwork
   3. Stainless Steel Back-Draft Dampers (BDDF)
   4. Stainless Steel Balancing (BF) Valves
   5. Stainless Steel Isolation (BF) Valves
   6. Moisture (Mist) Separator Assembly
   7. Air Flow Measuring Stations (AFMS)
   8. Air Flow Meters (AFM)
   9. Back Pressure Relief Valve (BPRV, in HOG exhaust system)
   10. Vacuum Relief Valve (VacRV, in both PCE & HOG exhaust system)

   "High-Pressure Ductwork" in this context shall be defined as piping except a minimal amount of sheet-metal transition that is necessary to connect the exhaust piping to the pre-assembled Back-Draft Dampers installed in the exhaust system. The back-draft dampers are "Safety Significant" and designed to prevent reversal of airflow.

C. The specification requirements are organized as follows:
   1. Materials
   2. Welding Requirements
   3. Damper / Valve Function
   4. Damper / Valve Configuration
   5. Construction
   6. Damper / Valve Leakage Rates
   7. Moisture (Mist) Separator Assembly
   8. Air Flow Measuring Stations (AFMS)
   9. Air Floe Meters (AFM)

D. Related Sections, The following Sections contain requirements that relate to this Section:
   1. Division 15, Section 15067, "Special Piping Materials."
   2. Division 15, Section 15074, "Identification and Labeling."

3. Division 15, Section 15100, “Valves.”
4. Division 15, Section 15820, “Duct Accessories.”
5. Division 15, Section 15990, “Testing, Adjusting and Balancing.”
6. Division 18, Section 18100, “General Welding Requirements.”

1.3 REFERENCES

A. The American Society of Mechanical Engineers (ASME):
1. ASME B16.21-92, Nonmetallic Flat gaskets for Pipe Flanges.
2. ASME B31.3-96, Process Piping.
3. ASME N509-89, Nuclear Power Plant Air-Cleaning Units and Components.
4. ASME N510-89, Testing of Nuclear Air-Cleaning Systems.
5. ASME SA-182/SA-182M-98 Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings and Valves and Parts for High Temperature Service.
6. ASME SA 312/SA312M-98 Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
7. ASME SA-358/SA358M-98 Specification for Electric Fusion Welded Austenitic Chromium Nickel Alloy Steel Pipe for High-Temperature Service.
8. ASME SA 403/SA-403M-98 Specification for Wrought Austenitic Steel Piping Fitting.

B. American Society for Testing and Materials (ASTM):
1. ASTM A193-97a, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service.
2. ASTM A 194-97, Standard Specification for Carbon and Alloy-Steel Nuts and Bolts for High Pressure and High Pressure Service.
3. ASTM A 380-96a, Standard Practice for Cleaning, De-scaling, and Passivation of Stainless Steels Parts, Equipment, and Systems.
4. ASTM A240-94, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless-Steel Plate, Sheet, and Strip for Pressure Vessels.
5. ASTM A262-93, Rev. A, “Standard Practices for Detecting Susceptibility to Inter-granular Attack in Austenitic Stainless Steels.”
6. ASTM A276-94, “Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.”
7. ASTM D1056-91, “Standard Specification for Flexible Cellular Materials-Sponge or Extended Rubber.

C. Engineering Standards (ES):
1. ES-5.11-2, Instrument Test Ports, Welded Rectangular Duct.
2. ES-5.11-6, Instrument Test Ports, Welded Round Duct.

D. National Fire Protection Association (NFPA):
1. NFPA 90A-93, Standard for the Installation of Air Conditioning and Ventilating Systems.

E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
1. SMACNA, HVAC Air Duct Leakage Test Manual, 1985.
2. SMACNA, HVAC Duct Construction Standards - Metal and Flexible, 1985.
3. SMACNA, Round Industrial Duct Construction Standards, 1977.

1.4 SUBMITTALS

A. Product Data: Provide shipping and installed operating weights; specialties and accessories furnished. Indicate dimensions, required clearances if required, and description of

procedures of assembly of various components, backdraft-dampers, piping and wiring connections as required.

B. Prior to start of fabrication, submit for approval the following to the Construction Manager:
1. Design Data: Provide large scale (not less than ¼" = 1' 0") layout drawings indicating all duct network/pipe runs, joints, fittings, backdraft dampers, accessories and supports. Indicate in sufficient detail to verify that products meet or exceed specified requirements. Identify duct / piping deviation from the referenced design drawings.
2. Certified Material Test Reports (CMTRs).
3. ASTM A-262, Specimen Selection Procedure and Laboratory Corrosion Test Reports.
4. Material identification (mill certified).
5. Material Trace ability procedure.
6. Material control procedure.
7. On critical systems, submit prior to leak testing the Duct / Piping Leakage Test Procedures for approval as designated on drawings.
8. Delivery schedule.

C. Submit for approval upon the completion of work, completion of test, or prior to concealment of ductwork system.
1. Test and Inspection reports.
2. System leak test reports with attachments.
3. Copies of non-conformance / deviation reports.
4. Material certifications complete with full tractability back to the manufacturer's heat numbers.
5. Trace ability documents.
6. Weld maps.

D. Submit for approval, documentation of the results for the following tests. Submit documentation prior to shipping.
1. Structural capacity (or structural capability) test in accordance with Chapter 6 of ASME N510.
2. The leakage rate test calculations in accordance with Chapter 6 of ASME N510 and Table B-3 of ASME N509.
3. Weld Inspection and examination reports.

E. Submit for approval upon the completion of work redlined "as-built" drawings.

F. Provide Certified documentation of material Bending Process utilized.

1.5 SCHEDULING

A. Notify Construction Manager (CM) prior to actual fabrication start date. The CM shall have the option to inspect prior to, during, and upon completion of fabrication and installation of the work and conduct witness tests and inspections.

PART 2 - PRODUCTS

2.1 MATERIALS: The material requirements for HOG, PCE and BDCE exhaust piping, ductwork and accessories shall be as defined in specification Section 15067, "Special Piping Materials" and as follows:

A. Pipe (Schedule 10S): Material Specification MS-07-SS-4, Section 15067.

B. Pipe Fittings (Schedule 10S): Material Specification MS-07-SS-8, Section 15067.

C. Flanges (Schedule 10S): Material Specification MS-07-SS-13, Section 15067.

D. Tubing: Material Specification MS 07-SS-14, Section 15067.

E. Tube Fittings: Material Specification MS-07-SS-15, Section 15067.

F. Bar: Material Specification MS-04-SS-5, Section 15067.

G. Plate: Material Specification MS-04-SS-25, Section 15067.

H. Sheet/Strip: Material Specification MS-04-SS-50, Section 15067.

I. Gaskets for flanged duct/piping joints: 1/4 in. thick, full face, closed cell, expanded neoprene sponge, ASTM D 1056, Grade SCE-43.

J. Bolts: AISI Type 304 Stainless Steel, ASTM A193 Grade B8 Class 1, semi-finished heavy hex head, UNC threads.

K. Nuts: AISI Type 303 Stainless Steel, ASTM A194 Grade 8F, semi-finished heavy hex, UNC threads.

L. Marker (for Stainless Steel surfaces): Maximum 250 ppm (parts per million) by weight chlorides, fully soluble in water.

M. Solvent: Potable water containing maximum 15 ppm total halides.

N. Wire Brush: Stainless Steel.

O. Grinding Wheel: New or previously used on Stainless Steel only.

P. Stainless steel structural shapes: In accordance with ASTM A276.

Q. Stainless Steel duct transitions for PCE exhaust systems: To facilitate Stainless Steel piping connections to Safety-Significant “Back-Draft” Dampers.

R. Stainless Steel pipes, fittings, flanges, sheets, plates, tubing, and shapes that are pressure boundary materials (i.e., positive or negative pressure boundary materials) shall be mill certified, 304L stainless steel and have a maximum carbon content of 0.030% ladle analysis and shall also be tested in accordance with ASME A262. Materials shall meet the requirements of the appropriate Material Specifications identified in Section 15067 with the following exception.
   1. Two (2) random specimens from each material lot shall be subjected to the oxalic-acid test (ASTM A262, Practice A). A “step” etch structure classification (as defined in ASTM A262) shall be required to pass this test. If both specimens from each lot pass this test, then the lot from which they are taken is qualified. For lots with specimen failing this test, subject specimens to the nitric-acid weight loss test (ASTM A262, Practice C) as defined in the appropriate Material Specifications in Section 15067.

2.2 WELDING REQUIREMENTS

A. Perform welding activities per Section 18100, General Welding Requirements, and the following:
   1. All piping and sheet metal welding shall be performed using the Gas Tungsten Arc Welding process with argon for shielding and backing gas in accordance with qualified procedures.

2. Welding backing rings, strips, or consumable inserts shall not be used.
3. Welding shall be performed by qualified welders and in accordance with the welding procedures established herein and in Par 3.3, “Quality controls”.
4. All groove and butt welds shall be welded continuously and shall have full joint penetration. Back welding of groove welds shall be acceptable.
5. All fillet welds in contact with the air stream shall be continuous to eliminate cracks and crevices.
6. All pressure boundary weld joints and seams shall be welded continuously.
7. Contractor shall qualify a welding procedure in all positions to be used in production. For material thickness greater than or equal to 0.125 in., AWS D1.1 or ASME Section IX shall be used. For material thickness less than 0.125 in., AWS D1.3 shall be used.
8. Welders and welding operators shall be qualified in all positions to be used in production. Qualifications shall include the thinnest gage material used in production.
9. For HOG and PCE fabricated from pipe, select a pipe welding procedure from Section 18350 appropriate for the materials and weld process.

2.3 DAMPER / VALVE FUNCTION

A. Back-draft Prevention: To prevent reversal of airflow of any airborne contaminated air stream.

B. Pressure Relief, Back-Pressure Relief: To limit excessive pressure or differential pressures build-up respectively across two adjoining spaces or equipment from a predetermined, controllable level.

C. Vacuum Pressure Relief Valve: To eliminate excessive static pressure buildup by allowing clean (room) air to enter to the exhaust piping/ductwork upstream of the HOG or PCE Exhaust Fan system in the event in-line isolation dampers/valves are closed for any reason.

2.4 DAMPER / VALVE CONFIGURATIONS

A. Parallel Blade Damper. A multi blade damper having blades, which rotate in the same direction with centrally located, balanced blades.
1. Construction Class B dampers meet the requirements for valves of ANSI/ASME B31.1, Process Piping.
2. Construction Class B dampers shall be industrial quality construction as specified in Par. 2.3D.

B. Butterfly Valve. Provide valve as per specification 15100, Valve data sheet V-6489 designate. Valve shall be centrally pivoted, balanced blade, designed for higher pressures (25 PSI Min.) and which meets the requirements of Construction Class B.
1. Valve Bonnet Gaskets (for replacement): non-asbestos expanded Neoprene, ASTM 1056. Grade SCE-43, or reinforced Teflon PTFE, ASTM D4894.
2. Flanged Joint Gaskets Neoprene gaskets per ASTM 1056, Grade SCE-43, shall be used for flanged joint gaskets in the PCE and HOG systems.

Table 15895-1

Service	Size (in.)	Number	End type

Shutoff

Butterfly	3" and above	V-6489	Wafer
Ball	2" and smaller	V-1181	Flanged

C. Back-Pressure/Relief Regulator (BPRV): Provide and install a suitable size and capacity BPRV downstream of the moisture (mist) eliminator and upstream of HEPA filter assemblies in the Hot Off Gas (HOG) exhaust system only as indicated on drawings.
   1. The valve shall capable to limit excessive differential pressure build-up between the low pressure HOG tank and the higher HEPA filter exhaust fan system.
   2. Valve end connections and material shall be compatible with Target Building HOG exhaust materials which is constructed of ASME SA312, 304L, Schedule 10, Stainless Steel piping. Connections shall be flanged for easy removal and replacement unless otherwise indicated on drawings. Coordinate valve connection design with piping as required.
   3. Valve operating temperature range shall be form -20◦F to 150◦F (-29◦C to + 66◦C).
   4. Valve body and spring chamber shall be Stainless steel, seal and seat materials shall be radioactive resistant "Ultra High Molecular Weight Polyethylene" (UHMWPE). Valve seat leakage rates shall comply as defined in Par. 2.5 C below.
   5. Valve exterior surfaces shall be painted with manufacturer's No.S-1547 EPOXY finish.
   6. Valve shall be as manufactured by "CASHCO"", Model 8311HP-2" or approved equal, with diaphragm design. Diaphragm shall be suitable for low-level, negative: -2.2 PSI (-60 inches of Water Gage (WG) exhaust air operation.

D. Vacuum Relief Valve: Provide and install a Normally Closed (NC), suitable size and capacity Vacuum Relief Valve (VacRV) downstream of HEPA filter assemblies, and upstream of each HOG and PCE exhaust fans as indicated on drawings.
   1. The valve shall capable to allow uncontaminated, room make-up air to enter to each type of exhaust system when for any reason the dedicated HEPA filter banks are isolated "off-line" thus exhaust air volume to the exhaust "fan/pump" is reduced.
   2. Valve end connections and materials shall be suitable to be fitted in HOG/PCE exhaust piping constructed of ASME SA312, 304L, Schedule 10, Stainless Steel. Coordinate valve connection design with piping as required.
   3. Valve operating temperature range shall be form -20◦F to 150◦F (-29◦C to + 66◦C).
   4. Since the valve is functionally operates in a "clean" environment, and the transported effluent is also cleaned-up, the materials of construction does not have to meet contaminated effluent standards. Seal and seat materials shall be TFE or Manufacturer's standard. Valve seat leakage rates however shall still comply as defined in Par. 2.5 C below.
   5. Valve diaphragm shall be suitable for very low, negative -2.2 PSI (-60 inches of Water Gage WG) exhaust air operation.
   6. Relief Valve shall be similar to vacuum relief valve used for preventing vacuum pump "cavitation" on rapid changes of vacuum requirements. Kinney, Arlan, U.S. turbine, Val-Matic, VAT Inc. or approved equal.

2.5 CONSTRUCTION

A. Fabricate the HOG, BDCE (where indicated on drawings), and PCE systems to engineered safety feature unit, Leakage Class II, Bubble tight as determined by ASME N509.

B. Verify that the materials are of the type specified in the appropriate Material Specification Section 15067; and that the materials have approved Certified Material Test Reports (CMTRs) and have approved ASTM A262 Laboratory Test Reports.

C. Design Pressure limitations for the HOG, BDCE and PCE systems are defined in ASME N509. Design pressures for this specific application is substantially lower and is as follows:
   1. Maximum operating pressure shall be –2.2 PSI. Negative -2.2 PSI (-60 inches of Water Gage (WG).
   2. The leak test pressure shall be 1.25 times (2.75 PSI), the maximum operating pressure.
   3. The maximum design pressure shall be the pressure in the system when the fan dead heads (3.5 PSI).
   4. The structural design capability pressure shall be 1.25 times (4.375 PSI) the maximum design pressure.

D. Hot Off-Gas (HOG) exhaust air, Primary Confinement Exhaust (PCE) and Beam Dump Confinement Exhaust (BDCE) air systems shall be constructed from ASME SA312, 304L, Schedule 10, Stainless Steel piping.

E. Back-Draft dampers: Furnish and install of size and capacity, where indicated on drawings counterbalanced back-draft dampers to prevent the reversal of airflow in high pressure, high velocity applications. Damper construction criteria shall meet Table 15895-3, and all parts in the air-stream shall be Stainless Steel materials. Dampers shall be of industrial quality construction: all parts, including frame, blades, pivots, axles and bearings. Pressure limitations for the PCE systems are defined in ASME N509.
   1. Frames shall be rolled, formed, or fabricated into a 10”x 2” channel, 10 gauge Stainless Steel through 60” width or height, 10” x 2-1/2” x 3/16” thick Stainless Steel through 80” width or height, Frame deflection under design loadings shall not exceed s/360 of the span in any direction. Dampers shall have pre-drilled mounting flanges suitable to be installed between flange sections of ductwork.
   2. Blades shall have a maximum width of 7-15/16” and shall be fabricated of 16 gauge Stainless Steel through 32” damper width, 14 gauge Stainless Steel over 32” damper width. Damper blades shall be equipped with radiation and corrosion resistant seals.
   3. Axles shall be constructed of 304L Stainless steel, full-length, ¾” diameter, except dampers smaller than 19” x 19” may be designed with minimum shaft diameter of ½ inch. Blade edge and axle deflection shall not exceed L/360 of span or 1/8 inch, whichever is less, under the forces produced by operation of the damper at 1.5 times the design conditions for flow and pressure, and shall not cause the low-leakage criteria defined in Table 15895-2 to be exceeded.
   4. Linkage shall be located outside of the air stream, and component design shall include at least the following minimum requirements. Counterbalanced for easy operation.
      a. Brackets, arms, angle stops and levers shall be of sufficient length and stiffness to provide stable operation of the valve blades without flutter or binding, at all blade positions.
      b. The Linkage system shall be designed to deliver sufficient torque to each blade to properly set the seals of each and every blade.
      c. All linkage components shall be designed to transmit the required torque without exceeding the maximum stresses allowed. The required torque shall be defined as twice the portion of the damper torque the component is expected to transmit or the maximum actuator torque capability when the component may be required to transmit the full torque capability of the actuator.
      d. Bearings: Bearings shall be relubricable ball type or rolling element type for temperatures of 200 deg F or less with grease fitting for lubrication. Bearings for vertically oriented blades shall be designed for thrust loads.
   5. Fabricate valve and fittings with continuous butt-welded joints and seams. Fillet-welded seams are allowed at corners only.

F. Round Dampers in or out of piping.

1. Round dampers: Utilize stainless-steel butterfly valves V-6489 as indicated in Table 15895-1 above, for round damper application. Provide suitable flanges for connection to piping and accessories.

2.6 DAMPER / VALVE LEAKAGE RATE

A. The following leakage test shall be conducted on each Class II damper / Valve assembly. The damper assembly shall be bolted to a sealed chamber, which is then pressurized to the specific pressure; there shall be no bubbles when tested with a soap solution in accordance with the Bubble Method of leak detection in ASME N510-1989.

B. Damper Leakage Classification: In accordance with AMCA 500 provisions, damper leakage rates shall be in as indicated in Table 15895-2.

TABLE 15895-2
MAXIMUM PERMISSIBLE DAMPER LEAK RATE
CLASS II

Damper Blade Length WG Differential pressure	Maximum Permissible Leak Rate (SCFM / SQ.FT of Damper Face Area)
Up to 12	15
24	10
36	8
48	8

TABLE 15895-3
DAMPER CLASSIFICATION FOR CONSTRUCTION AND LEAKAGE

Function Of Damper	Construction Class	Leakage Class
Back draft prevention:		
a. Contaminated air stream	B	II
b. Non-Cont. Air stream	B	II
Pressure relief	B	II

1. Construction Class: Sheet metal gages and structural angles used for fabrication and reinforcement of the round dampers in ductwork for negative pressure systems are to be sized and positioned in accordance with Class B construction requirements for the pressure class shown on the drawings. Weld the reinforcement angles to the damper by 1-inch-long fillet welds equally spaced and staggered on alternate sides of the angle. Weld-leg size to be at least equal to the sheet metal thickness. The round damper reinforcement angles to be rolled to the nominal duct diameter and be made continuous by butt-welding together the angle ends. s

2. Round damper fittings to have butt-welded joints and seams. Tee connections to be of the conical type.
3. Weld reinforcement stiffeners to the pipe/duct with 1-in.-long fillet welds staggered and spaced on 12-in. (max) centers. Weld leg size to be at least equal to the sheet metal thickness.

2.7 MOISTURE (MIST) SEPARATOR ASSEMBLY

A Provide a suitable size and capacity Moisture (mist) Separators assembly for the Hot Off-Gas (HOG) exhaust system to prevent entrained moisture carryover in the exhaust air stream from the HOG tank to filter banks as indicated on drawings.

B. Moisture (mist) separator may be similar to "oil-mist" separators used in the Vacuum Pump industry. Separator assembly materials shall be of 304 Stainless Steel, welded construction. End connections shall be welded or flanged. Assembly shall be complete with drainage connection. Gravity drain connection shall be extended back to HOG tank as indicated on drawings.

C. Separator housing assembly shall utilize a removable a circular canister(s) type elements or knitted stainless steel wire-mesh pad configuration. The canister element or the wire-mesh shall be secured in the housing with a retainer. Separator elements shall be removable from the top or side-access configuration as indicated on drawings, from the housing for maintenance or replacement.

D. Assembly shall be as manufactured by Kinney Vacuum pump Division, Style D (canisters), ACS Industries Inc. (wire-mesh pad type), or approved equal.

2.8 AIR-FLOW MEASURING STATION (AFMS)

A. Provide as indicated on drawings, size and capacity "Airflow Probe Transverse Station" capable of continuously monitoring the quantity of (moderately disturbed) airflow volumes transported in the ductwork. Each AFMS shall utilize one or more VOLU-probes, factory mounted in a rigid welded galvanized (or Stainless Steel as indicated for specific service) casing, to sense and average separate total and static pressure traverses of an air stream with a certified accuracy of 2% or better when tested according to AMCA 610. Each station contain multiple sets of "Fechheimer Pitot" total and static pressure sensing ports, positioned on an equal area basis along the length of each probe, transverse the duct cross-section and average the sensed pressures in separate internally connecting manifolds. For stations of 4 square feet or less, one total and one static pressure sensor shall be present for every 16 square inches of station area respectively. For stations of larger area, one total and one static pressure sensor shall be present for every 36 square inches of station area respectively.

B. The stations shall have minimal self-generated sound rating, and the sound level within the duct shall not be amplified, nor shall additional sound be generated.

C. The airflow measuring station shall be as fabricated by Air Monitor Corporation, Model "VOLU-Probe / VS Airflow Probe Traverse Station" or approved equal.

D. Each station shall be complete with an open parallel cell airflow "straightener" or air equalizer honeycomb upstream of probes, mechanically fastened to the casing. An identification label shall be placed on each station casing listing model number, size, area, and specified airflow capacity.

E. AFMS Control interface: Each station shall be complete (shipped loose, installed by control contractor) with a matching capacity range of "Differential Pressure / Flow transmitter" in a NEMA 12 enclosure. Transmitter shall be microprocessor based, ultra-low differential pressure and flow "smart" type with a 0.15% of Natural Span accuracy suitable for HVAC applications. Transmitter shall be analog output configurable for 4-20 mADC, AUTO-zero capability, digital low pass filter, and 5:1 turndown capability. Provide a suitable 12VAC to 24VDC transformer as part of the package. Air Monitor, Model "VELTRON DPT 2500-plus" or approved equal.

2.9 AIR-FLOW METERS (AFM)

A Provide and install of type, size and capacity of process exhaust Flow Meters as indicated on drawings: Process exhaust systems are as follows:

1. AMSH-TA-01 Hot Off-Gas (HOG) Exhaust system airflow meter.
2. AMSB-INJ-02 beam Dump Confinement Exhaust (BDCE) system airflow meter.
   a. Air Flow Meter shall be thermal dispersion type, designed to operate at a negative static pressure limit of –60" W.C. (2.2 psig) at 100 ◦F maximum.
   b. All sensor-wetted materials shall be constructed of 316 Stainless Steel.
   c. Meter size shall be 1" diameter, "In-Line" configuration, with one (1) inch NPT threaded end connections (approx. length: 15").
   d. Measurement range shall capable of very small 0 to 6 SCFM mass flow capacity measurements with traceable NIST calibration.
   e. Electrical characteristics: 24 VDC input power and 4 to 20 ma output power.
   f. Minimum measurable flow rate shall be: 0.1 SCFM.
   g. Meter shall be complete with an integral NEMA 4X electronics enclosure.
   h. Meter shall be FOX, Model 10A-10D-SSS-ELE-DO-ST-NAA-AIR inline thermal or process control Engineer approved equal.
3. AMSP-TA-01 Primary Confinement Exhaust (PCE) system airflow meter.
   a. Air Flow Meter shall be thermal dispersion type, designed to operate at a negative static pressure limit of –60" W.C. (2.2 psig) at 100 ◦F maximum.
   b. All sensor-wetted materials shall be constructed of 316 Stainless Steel.
   c. Location, type, size and capacity range shall be as designated on drawings.
   d. Meter shall be "Insertion" or "In-line" configuration, for threaded or 150 lbs. flanged end connections as required.
   e. Measurement range: 15 to 4,000 SCFM mass flow capacity measurements and traceable NIST calibration.
   f. Electrical characteristics: 24 VDC input power and 4 to 20 ma output power.
   g. Meter accuracy shall be $\pm$ 0.75% of reading +0.5% of full scale.
   h. Meter shall be complete with an integral NEMA 4X electronics enclosure.
4. Fabricate and secure air-distribution devices and accessories, such as dampers, diffusers registers or grilles to piping as designated on drawings and described herein.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that openings for the installation of the duct system are of the size and in the location shown on the drawings, that openings are clear of obstructions, which might interfere with the installation of the ductwork or accessories, and no other interferences exist in the routing of ductwork. Notify the CM of conflicts. The CM will review to determine a resolution.

3.2 INSTALLATION/APPLICATION/ERECTION

A. Install and support all HOG & PCE ductwork systems in accordance with PC-2 qualified designs and details shown on the structural drawings or the hot cell (i.e., J-series) drawings.

B. All Stainless-Steel sleeves and Stainless-Steel piping embedded in concrete shall be wrapped with 3M Scotch rap 51, used in conjunction with Scotch rap primer.

C. Safety Significant, Primary Confinement Exhaust (PCE) backdraft dampers: Provide low leakage type, Class B, backdraft dampers in Target Building High Bay (see Drawing. H2.03.45) to prevent contaminated exhaust air backflow from HEPA filter side of system. Two backdraft dampers shall be installed in series (as to create a “double check” function should the first damper fail to prevent backflow of possible contaminated air reversal) as indicated on drawings. Provide all necessary duct transitions upstream of backdraft damper and HEPA filters as required.
Backdraft damper size and capacity as indicated on plans.

3.3 FIELD QUALITY CONTROL

A. Perform weld inspection and examination per Section 18100, General Welding Requirements, and the following:
   1. All HOG, PCE and BDCE welds shall be inspected 100% visually, 100% by liquid penetrant means. Liquid penetrant examination of pressure boundary welds shall be performed on the first pass and the final weld surfaces.
   2. Radiographic examination of the HOG, PCE and BDCE welds shall be performed 5% of all the welds performed.
   3. Welders’ performance requirements:
      a. Welders performing welds found to be unsound shall be subject to the appropriate re-test provisions of the applicable Codes or Standards.
      b. All welds are subject to inspection by the CM inspectors. The CM reserves the right to accept, rejects, or requires removal of welds, which do not meet specification or documentation requirements.
      c. Qualify welders and welding operators to weld using the appropriate approved and qualified welding procedure(s). Submit records of qualification, including updates, as required by the applicable code for the procedure. The welder qualification requirements and limits of qualification are those of the code for which the procedure is qualified.
   4. Linear indications (length greater than three times the width) exceeding 1/16 inch in length are rejectable for liquid-penetrant examinations.
   5. Examination Personnel Certification Requirements
      a. Personnel performing visual examination of welds shall be currently certified either as an AWS CWI or as a visual testing Level II per the employers written practice in accordance with SNT-TC-1A. If certified in accordance with SNT-TC-1A, the training and experience requirements shall be satisfied entirely by time spent in weld examination related work.
      b. Personnel performing nondestructive testing other than visual shall be currently certified in accordance with SNT-TC-1A. Only individuals certified as NDT Level II or III may perform nondestructive testing.

B. Duct Leakage Tests shall be in accordance with ASME N509 & N510:
   1. Leak test the exhaust systems as follows: The maximum leak rate for the entire exhaust system shall be 0.10% of the total system flow at a test pressure of negative minus five (-5) PSI (-138.5 “ WG) in accordance with ASME N509, Appendix B, Table B-3. Unit leakage rates for subparts shall be calculated using the equation

accompanying Table B-3. The ductwork shall be tested as an engineered safety feature unit, Leakage Class II.

2. Perform duct leakage testing in accordance with ASME N510 using the Pressure Decay Method (Section 6.5.3) and shall be witnessed by the Construction Manager.
3. The ductwork leakage test report shall be in accordance with ASME N510.
4. If ductwork fails to pass the leakage test, repair it to bring it into compliance and retest it until acceptable leakage is demonstrated.
5. Notify Construction Manager (CM) for inspection prior to concealment of ductwork.
6. Prior to exhaust systems leak testing, the exhaust systems shall be given structural capacity tests at a positive pressure of five (+5) PSI (+138.5 In. WG) and also at a negative pressure of five (-5) PSI (-138.5 Inch WG) minimum in accordance with chapter 6 of ASME N510.
7. Permanent distortions found in the exhaust systems, as a result of the structural capacity test shall be repaired, structurally strengthen, and retested.

C. After the ductwork is installed, verify by inspection and document that:
   1. Dampers are installed in the proper configuration and location shown on drawings;
   2. Instrument test ports are installed, in the correct positions, and opening through duct wall is full inside port dimension in accordance with Engineering Standard ES-5.11-6;
   3. Duct interiors are free of construction debris;
   4. Ductwork is sealed; and
   5. Air-leakage test report completed.

END OF SECTION 15895